UNITED NATIONS
ECONOMIC AND SOCIAL COUNCIL

Distr.: GENERAL
E/ECA/CM.13/11
24 February 1987
Original: ENGLISH

ECONOMIC COMMISSION FOR AFRICA

Eighth meeting of the Technical Preparatory Committee of the Whole

Addis Ababa, Ethiopia
13 - 20 April 1987

Item 6 of the provisional agenda*

ECONOMIC COMMISSION FOR AFRICA

Twenty-second session of the Commission/ thirteenth meeting of the Conference of Ministers

Addis Ababa, Ethiopia
23 - 27 April 1987

Item 5 of the provisional agenda**

LG/NAIROBI.

REPORT ON MEASURES TAKEN BY AFRICAN COUNTRIES TO REDUCE POST-HARVEST FOOD LOSSES OVER THE PERIOD 1975-1985

---

* E/ECA/TPCW.8/1.

** E/ECA/CM.13/1.

87-

FOREWORD

In consonance with resolution 3362 (S-VII) adopted in 1975 by the seventh special session of the United Nations General Assembly, which called for a 50 per cent reduction of post-harvest food losses in developing countries by 1985, and with the specific recommendations on the development of the food and agricultural sector contained in the Lagos Plan of Action for the economic development of Africa, the Economic Commission for Africa (UNECA) incorporated in its biennial work programmes a number of activities aiming at sensitizing member Governments on the importance of reducing post-harvest food losses in the overall strategy for food self-sufficiency and at assisting member countries in their efforts to tackle the problem.

This report is an output of the programme element related to activities on reduction of post-harvest food losses contained in the approved work programme and budget of the Commission for the biennium 1986-1987. Its main objective is to report to the eighth meeting of the Technical Preparatory Committee of the Whole, to the thirteenth meeting of the Conference of Ministers and to the General Assembly on measures taken by African member States to reduce post-harvest food losses over the period 1975-1985.

Following the introduction which gives the background of growing concern about the issue, the paper provides:

(a) An overview of the main causes of post-harvest food losses and their present importance in Africa;

(b) The salient features of measures taken by member States and supportive international organizations and development agencies; and

(c) Some proposals for a future strategy to further reduce post-harvest food losses in Africa.

INTRODUCTION

1. Early in the 1970s, the marked decline of the per caput availability of locally produced food in the developing world and more particularly in Africa became alarming. In Africa this decrease has been significant and the per caput cereals availability decreased from 166 kg in the early 1950s to 154 kg in the 1970s. The spectre of recurrent famines became preoccupying as projected and aggregate agricultural output for the next decade did not cope with that of the growing population. Against this background, most of the proposed and adopted strategies aimed at boosting agricultural production and little attention was paid to saving a good part of what have been harvested. While considerable amounts of food were lost by pests, diseases, rodents and waste at a time when millions of people were either starving or suffering from malnutrition. Even when it became notorious that reducing the losses of produced food in developing countries would have to play an important part in the overall effort for increasing food availability, activities towards preventing post-harvest food losses were limited to a few initiatives of some development agencies without an effective involvement of developing countries themselves and by no means that of subsistence farmers.

2. It is really in 1974 that the importance of the post-harvest aspects of cereal-grains losses in developing countries were highlighted by the Food and Agriculture Organization of the United Nations (FAO) at the World Food Conference held in Rome. It revealed that post-harvest food losses of cereal-grains can reach as high as 30 per cent in the hot moist air of the tropics and around 10 per cent in the arid zones; for more perishable crops, the figures could be as high as 40 per cent. For fishery products, some estimates placed losses among the highest for all commodities, reaching as high as 50 per cent. The perishability of meat and dairy products were also estimated to be very high. Although estimates of post-harvest losses were at that time based on subjective judgements and scant observations, the magnitude of the problem provided necessary incitement to sensitize and stimulate countries and the international community to give the right consideration to the problem of post-harvest food losses.

3. Responding to this long-standing need, the issue received some prominence at the seventh special session of the United Nations General Assembly in 1975, whose resolution 3362 (S-VII) on the development and international economic co-operation included in the operative paragraph on food and agriculture, the following:

> "The further reduction of post-harvest food losses in developing countries should be undertaken as a matter of priority, with a view to reaching a 50 per cent reduction by 1985. All countries and competent international organizations should co-operate financially and technically in the effort to achieve this objective particularly in the systems of distribution of foodstuffs".

4. In Africa where the food and agricultural sector has drastically deteriorated over the years since the 1960s, and where severe food shortages brought about unprecedented famines and increased dependence on food imports, the problem of food availability and food security has been more than preoccupying. Because of the recurrent drought and the low capacity of investment in the agricultural sector, most of the member countries and more particularly those in sub-Saharan Africa have not been able over the last two decades to boost production like in other developing regions. Therefore, securing a substantial reduction in food losses and wastage have been seen as an important component of food security strategies. On the basis of these considerations, the Lagos Plan of Action

for the economic development of Africa (1980-2000), adopted by African Heads of State and Government, fully endorsed the recommendation included in the United Nations General Assembly resolution 3362 (S-VII) and urged that actions towards reducing food losses must include the following:

(a) Careful assessment of the extent of food losses;

(b) Formulation of national policies for food loss reduction;

(c) Mass-media campaigns to educate the public on methods of reducing food waste;

(d) Construction of appropriate storage, processing and other facilities;

(e) Establishment of central technical units;

(f) Promotion (through research, infrastructural development and incentives to farmers and fishermen) of improved methods of drying, preservation, storage, pest control and processing;

(g) Improvement of livestock routes and holding grounds; and

(h) Training of technical staff for food loss control, preferably through subregional/regional institutions, seminars and workshops.

5. Ten years after the adoption of resolution 3362 (S-VII) by the United Nations General Assembly calling for the reduction of food losses by half over the period and five years following the recommendations for specific measures towards attaining the same goal made by the African Heads of State and Government, the problem of food losses in general and of post-harvest food losses in particular remains a real problem for Africa in the context of the present crisis, characterized by acute food shortages and food insecurity. During the past 10 years, a lot of valuable activities aiming at assessing the extent of reduction of food losses have been undertaken by member States with the assistance of development agencies and international organizations. However, the question on whether such activities have contributed to the attainment of the goal of halving the magnitude of food losses or reducing it by a given percentage is rather difficult to respond to at this stage.

I. AN OVERVIEW OF THE POST-HARVEST FOOD LOSSES IN AFRICA

6. In 1976, the Food and Agriculture Organization (FAO) estimated losses of cereals and legumes grains in developing countries to be at least some 42 million tons. Based on projections of food crop production and on the assumption of continued losses at the same relative level, the Organization estimated that the minimum post-harvest food losses would be about 110 million tons in 1985. Although latest data on this issue is not available, the indications are that the trend and magnitude of loss are substantial. For the African region, post-harvest food losses were estimated at about 7 million tons for cereals alone in 1977. At the 1975 prices, such loss was worth $US 930 million or equivalent to 45 per cent of the actual total cereal imports of the region in 1984.

7. The above figures are illustrative and show the magnitude of the problem. However, this global estimation does not reflect the prevailing situation in a given country as post-harvest food losses are commodity- and location-specific. The nature and magnitude of losses vary greatly with the nature of the commodity (whether it is durable or perishable), the climate (degree of humidity and temperature), the high incidence of pests or combination of pests (insects, mites, micro-organisms and rodents) and the socio-economic setting. Also, the post-harvest losses which occur at each stage will differ from one commodity to another.

8. In Africa, durable crops include cereal grains such as maize, sorghum, millet, wheat and rice and legume grains like dwarf beans, cowpeas, pigeon peas and groundnuts; perishable crops include roots and tubers (mainly yam, cassava, sweet potato and potato), fruits and vegetables. Besides these main crops, the perishability of meat, dairy and fishery products is even higher. While meat and dairy products are usually consumed fresh in Africa, and more particularly in rural areas where ice plants and freezers do not exist, an important part of fishery products is cured (dried, salted or smoked) and stored for a long period. Only the case of such processed products for which storage problems are similar to cereal or legume grains will be dealt with.

9. For a given commodity, the climate is an important factor of deterioration or of safe keeping. High temperature and humidity are favourable to mold formation and rapid growth of insects. It has been observed that losses in the savannah zone are fewer than in the hot and humid forest zone. Also for a given commodity, the number of post-harvest operations and the nature of technology used will bring about more or less loss. Since these operations are different from one category of commodity to another, it will be practical to consider the problems separately.

A. Post-harvest losses in cereal and legume grains

10. After food grains are harvested, they are manipulated through a sequence of operations including threshing (shelling in the case of maize and decorticating for legume grains), drying, cleaning, parboiling in the case of rice, transportation, storage and processing before the end-product is suitable for consumption. Preliminary operations for obtaining clean grains are usually called primary processing while milling, baking, brewing, are processing operations. Each stage of the sequence will induce losses where magnitude will depend on grain nature (especially the structure of the kernel) and/or the appropriateness of the technology used.

1. Losses during primary processing

11. At this stage, the loss is quantitative and its magnitude is a function of the size of the grain and its structure. Table 1 gives some implications of these operations associated with the structure of the kernel. Traditional primary processing methods usually bring about breakage, germ damage and wastage. For these operations, the stage of harvesting is a critical factor as high moisture content of grain will increase losses and impair some functional properties, particularly during the drying period.

2. Losses during storage

12. The importance of storage in the post-harvest system is justified by the fact that in subsistence farming, farmers need to store the harvested products for a period separating two harvests. In areas of multiple cropping, the storage time will be limited from three to six months but in cases of single cropping, this period can be extended to 12 months. The degree of damage of stored products is likely to increase with the length of the storage. Also, for a given commodity of food crops, one variety will be more resistant than another to a certain range of pests and will be more adapted to certain modes of storage. In most cases, local varieties have proven to be more resistant to insects infestation and more adopted to traditional modes of storage. Given the nature of grain, the structure of the storage facilities will determine the type and extent of losses caused by biological factors. The main biological agents of deterioration of stored grains, both in weight loss and in quality loss, are insects, mites, fungi and rodents. The main rodents causing important losses are:

(a) Rathus norvegicus, the common brown rat;

(b) Rattus ratus, the black rat; and

(c) Mus musculus, the house mouse.

13. With regard more particularly to insect pests attacking stored products, the range of pests generating great losses includes: the grain weevil (Sitophilus), the flour beetle (Tribolum), the lesser grain borer (Rhizoperta), etc. A list of common insect pests in stores of the tropics is given in annex I. The specific cases of Trogoderma granarium (E) (beetle) and Prostephanus truncatus (Horn) (grainborer) deserve a special consideration because of the importance of damage they have caused and continue to cause and their rapid spread in Africa. Trogoderma granarium is a coleoptera which thrives in arid zones and where its natural predators (bacteria and fungi) hardly grow. This pest is a real danger for stored millet, sorghum, maize, rice, wheat, cowpea and groundnut. As this pest infests mainly threshed, shelled or decorticated grains, the damage it can cause in on-farm stores is limited. But in the Sahelian countries where the climate is optimum for the expansion of this pest and where chronic food deficit imposes to countries' importation and storage of huge quantities of grains, the danger is very great. According to L.A.W. Hayward 1/, 30 per cent of millet procured by the Office des produits vivriers in the Niger (OPVN) and estimated to be about 80,000 metric tons per year, are deteriorated by T. Granarium. This loss amounts to about 24,000 tons or $US 6 million in value at 1970 prices. He also reported that in Senegal out of 400,000 tons of rice imported in 1982, about 6,000 tons were destroyed by T. Granarium, corresponding to a value of $US 1.5 million. Prostephanus truncatus (Horn) is a coleoptera widely spread in Central America where it is known to destroy, but to a lesser degree, stored unshelled maize and other cereal grains. This insect pest was identified in Africa for the first time in 1980 in the Tabora region of the United Republic of Tanzania. Between 1981 and 1984, the pest

---

1/ The control of infestation of stored products by Trogoderma granarium and Prostephanus truncatus. In proceedings of an International Seminar held in Lome, Togo, from 10 to 15 December 1984. Published by the "Deutsche Geselschaft fin Technische Zusammenarbeit (GTZ)".

Table 1. Some implications of kernel structure

Signficiance in	Parameter	Effect	Commodity
Threshing	Germ damage or skinning	Reducing germinability, impaired storability	All cereal grains
Drying	Cracks, fissures and breakage; hardening	Reduced commercial value; lowered grade, impaired storability, dust formation, reduced starch yield	Mainly corn and rice
	Discolouration	Reduced commercial value; lowered grade	Mainly rice
Marketing	Breakage	Reduced commercial value in food processing	Mainly corn and rice
General use	High husk: caryopsis ratio or high pericarp: endosperm ratio	Reduced nutritional value as food or feed	All cereal grains
General use	Kernel shape and dimensions; proportions of tissues in the kernel, distribution of nutrients in the tissues	Yield of food products; nutritional value of cereal (or cereal products) as food or feed	All cereal grains
Malting	Germ damage, skinning, or inadequate husk adherence	Reduced germinability, uneven malting	Mainly barley and sorghum
Milling	Uneven surface, deep crease or uneven aleurone	Reduced milling yield	Mainly wheat and rice
Milling	Steely texture	Increased power requirements, starch damage, high water absorption, difficulty in air classification	Wheat and malt milling
Germinating-malting	Starch granule size	Uneven degradation	All cereal grains
Consumption-nutrition	Distribution and position of protein	Change in nutritional value	All cereal grains

Source: Post-harvest losses in quality of food grains. FAO, Food and nutrition paper 29, 1983.

has contaminated other maize-growing regions in the United Republic of Tanzania, in Burundi and Kenya. In 1984, Prostephanus truncatus was identified for the first time in West Africa, in Togo. Contrary to T. granarium, P. truncatus usually attacks unshelled maize cobs. Most of the damage it causes is therefore observed in on-farm stores and particularly in areas with high maize-growing potential. Also, this pest which was not virulent in Central America has been found a dangerous storage pest in Africa. A study conducted by the Tropical Development and Research Institute (TDRI) in 1980 estimated the magnitude of losses caused by P. Truncatus on maize in the United Republic of Tanzania to about 9 per cent. The study further estimated that the financial loss for this country would be about $US 27 million yearly if it happens that the pest is widespread to all maize-growing regions. The above-mentioned elements are self-explanatory on the danger of Trogoderma granarium and Prostephanus truncatus. The first pest inflicts great losses to stored grains in the chronic food-deficit countries of the continent and the second is a real threat in the promising maize-growing regions.

3. Losses during grain processing

14. Generally speaking, hard cereal grains such as millet, sorghum, maize and some legume grains are not available to consumers in a convenient ready-to-use form. Grains should be ground or milled into flour, then processed into some forms of food which can be kept safely. The usual traditional methods of pounding or grinding grains in Africa are not only laborious and time-consuming but also induce losses. Effectively, in repeatedly pounding, moisturing, sifting and winnowing the grains, the rural housewife will need 4.5 kg of whole grains to produce 3 kg of flour, bringing the rate of loss to 30 per cent during this process. Also, prior moisturing of grain before milling results in flour still containing about 30 per cent water and which turns rancid if not used within two days. Storing such flour without good drying opens way for microbial and fungal attack. In the case of rice, milling brings about breakage of a large part of the produce. Also, a recent study undertaken by the Tropical Produce Institute (TPI) has shown that as much as 50 per cent of small broken rice grains can be lost in the cooking water. Another source of important loss through grain processing is the alcoholic fermentation for producing beverage; the process simply halves the caloric value of the whole grain. The total post-harvest loss in cereal and legume grains will be the sums of all weight quality and energy losses occurring during all the stages of the process from the harvest to the final food ready for consumption. The part of losses occurred at each stage is hardly assessable except in few cases of pilot but limited studies. Table 2 gives estimates of total post-harvest losses or at various stages of the post-harvest system in some cereal and legume grains in selected African countries where such assessment was undertaken.

B. Post-harvest losses in roots and tubers

15. Although post-harvest losses in roots and tubers have not been widely assessed, their magitude is likely to be high due to the high water content of these commodities. Losses occur mainly during transportation, storage and processing but harvesting remains an important factor since if it is carried out bruising or otherwise damaging the produce, nothing much can be done to further improve the handling. Following the harvest, yam, cassava and potato lose weight through rapid dessication. The maximum length of possible storage of fresh produce varies from less than a week for cassava, to three months for potato and six months for yam. In the case of potato and yam, the traditional

Table 2. Order of magnitude of post-harvest food losses in cereal and legume grains in selected African countries in the 1980s

Countries	Percentage of losses				
	Harvest	Transport and handling	Storage	Processing	Global figur
		1. For cereal grains			
Botswana					20
Burkina Faso	2-10	2-7	4-5	8-10	
Burundi	2-5	-	15	1-2	
Cameroon	-	-	6	-	
Chad	5-20	5-15	10-40	-	
Libyan Arab Jamahiriya	5-10	-	10-20	-	
Mali					7
Morocco	5-10	0-2	5-10	0-2	
Mozambique	15-25	2-10	2-10	6-8	
Rwanda	-				20
Sudan	-	-	10	-	
Tunisia	1-3	2-3	4-6	-	
		2. For legume grains			
Burkina Faso	6	2	8	-	
Burundi	1	-	10	-	
Morocco			5		
Mozambique	3-6	2-5	7-15	-	

Source: Computed from fragmentary loss estimates made during various projects.

- : Information not available.

barn or other shelters do not prevent high losses caused by nematodes (mainly Scutellanema) fungi and bacteria, rodents and insects. During storage also, sprouting and respiration account for weight loss.

16. With regard to processing roots and tubers, it is usually cassava which traditionally is processed; yam is processed to a lesser extent into flour and the processing of potato is not that much developed in Africa. Cassava, particularly the bitter variety, is processed and dried. The process not only provides long-lasting products but reduces the toxicity due to the presence of Cyanogenic glycosides. Cassava flour or granules (gari) can be stored without serious damage if moisture content is about 12 to 13 per cent. However, like stored cereal and legume grains, produce can still be infested by insect and fungi. Peeled and dried cassava stored in the form of dried cossettes are also severely attacked by Prostephanus truncatus in areas already infested by this pest. Table 3 gives the estimates of losses in roots and tubers in some African countries where pilot assessments were undertaken.

Table 3. Estimated roots and tubers total losses in selected African countries

Countries	Estimated losses (in percentage)
Benin	35-50
Cameroon	35
Côte d'Ivoire	35-40
Ghana	15-30
Madagascar	5-10
Nigeria	15
Rwanda	35-55
Zaire	10-25

Source: Extracted from the "Report of the workshop on production marketing constraints on roots, tubers and plantations in Africa" vol. II, FAO, 1985.

C. Post-harvest losses in fruits and vegetables

17. Because of their high moisture content (50 per cent and over), fruits and vegetables are the most perishable after harvest under humid and hot environment, losses are clearly excessive. Crude harvesting tools like pickling poles will bring about blemish and injury at the harvest time, aggravating handling problems. Furthermore, unsuitable packaging materials such as large sacks, rough wooden boxes, bamboo baskets are contributing to bruising, crushing and puncturing produce, thereby contributing to rapid rotting. Traditionally, a few vegetables like okra, local vegetable leaves, pepper, etc., are dried for conservation. In most cases, storage of fruits and vegetables is a crucial standing problem due to the lack of processing technologies and the fact that the introduction

of cool stores is for the time being uneconomic. From a recent study 2/ undertaken in Togo, the magnitude of total losses of fruits ranges from 15 to 42 per cent for mangoes, 10 to 15 per cent for pineapples and 5 to 8 per cent for citrus. For vegetables, the estimated losses during the study were at the harvest stage only, 7 to 12 per cent for tomatoes and 2 to 3 per cent for okra. These figures could be representative of the situation in most African countries where the marketing of fruits and vegetables is not organized and where cool stores and processing facilities are lacking.

D. Post-harvest losses in cured fishery products

18. Traditional methods of processing fish include sun-drying, salting and smoking. The efficiency of these operations is directly affected by the species of fish (fatty fish may pose some problems), the expeditiousness of completing the operation before the fish is already putrid and the failure to remove the gall bladder. Losses incurred can be both of nutritional and quantitative nature. Their magnitude is related to the efficiency of the processing method and the environment in which the fish is processed and then stored. The nutrients loss is mainly related to protein damage induced by hot smoking. Quantity loss is related to infestation by fly larvae, moulds bacteria and insects (especially Dermestes Spp). Fragmentation during inadequate handling and transportation can also bring about serious weight loss. There are few precise data on the magnitude of losses in cured-fish but FAO reported that in Senegal, losses of unsalted fish could vary between 10 to 30 per cent during processing and distribution; that in Burkina Faso, 25 per cent losses due to Dermestes Spp. are typical and that weight losses due to fragmentation varies from 25 to 56 per cent, depending on the fish species, during transportation from Lake Chad to southern Nigeria.

E. Post-harvest food losses in livestock products

19. In Africa, most of the meat is consumed fresh and only a small portion is processed (sun-dried and spiced meat in arid zones; production of ham, bacon, sausages and other products mainly in countries of Eastern and Southern Africa). With the exception of sun-dried meat, fresh and other processed products are stored using refrigeration. In this case, losses incurred are likely to be minor. However, the use of refrigeration to preserve meat and processed products are still limited to urban slaughter houses. Seizure of infested meat or meat not proper for human consumption in slaughter houses is also part of post-harvest losses in livestock products. It is rather unfortunate that, due to the fact that the problem has not been surveyed, estimates of magnitude of post-harvest losses in livestock products hardly exist.

2/ Etude sur la production et la commercialisation de fruits et légumes au Togo : Rôle de la femme, CEA, 1985.

II. MAJOR EFFORTS IN REDUCING POST-HARVEST FOOD LOSSES

20. Attempts to preserve harvested food commodities had begun earlier than 1975 in most of African countries through the use of traditional methods of protecting stored products and processing fresh food. Although the causes of losses were more or less perceived, neither their magnitude nor the economic implications were assessed. Moreover, the problem was not tackled in a global post-harvest system but rather in a fragmented manner. The resolution of the United Nations General Assembly has not only stimulated the interest of African Governments but also contributed to bringing many agencies/organizations to joining efforts and resources for achieving quick results. Measures taken in reducing post-harvest food losses included the elaboration of loss assessment methods, the improvement of storage conditions, the improvement of handling and processing of food commodities and the training or education of personnel (including the farmers) involved in such activities.

A. Institutional framework of efforts

21. The importance of activities undertaken by member States towards reducing post-harvest food losses during the period between 1975 and 1985 varies from one country to another, depending on the priority accorded to the problems, the availability of resources, the efficiency of Government established institutions for the purpose and the socio-economic environment of the country. Also, efforts made by African member countries in reducing food losses have been significantly supported by many development agencies, international organizations and non-governmental organizations. Therefore, dealing with achievements so far made will necessitate giving the role of all parties involved.

1. Role of member countries

22. From information gathered from field missions and various available reports, it would seem that in most countries, the importance of food-saving measures has been given right consideration and sensitization campaigns were mounted through the mass-media, particularly through radio broadcasting. Also, during several fora, officials from member States reiterated their commitment to adopting practical measures for reducing food losses and waste as complementary actions in attaining food self-sufficiency. Practically all member countries have established plant protection services, while extension workers, in the limit of their means, have made valuable attempts to provide advice to farmers regarding simple methods of improving the existing post-production practices, to design and promote appropriate small-scale storage structures for farmers, and co-operatives or cereal banks. The national extension services particularly have popularized adapted traditional methods of pestcontrol such as rat guards, use of local herbs and ash to prevent grain stocks from infestation.

23. Besides the national plant protection services whose tasks have been more oriented to pre-harvest operations and less to post-harvest operations, the grain marketing boards have played a major role in associating activities for improvement of post-harvest operations with produce procurement, transportation and storage. Through the boards, Governments invested quite a lot in constructing central stores which are adapted to the prevailing environment and to the efficient use of contact chemicals and fumigants for pest control. The construction of large-scale structures has been associated with the training

of qualified teams for an efficient management of the stores. In addition to improving large-scale storage facilities, the boards, in some cases, promoted adequate drying and quality-control of produce. National programmes towards preserving harvested food also included the development of food processing facilities. It is noteworthy that in most countries, small-scale grain mills have been widely established in rural areas and such mills have been improved over the years so that multi-purpose mills are now available. Also, large-scale mills have been promoted, as well as bakeries, fruit canning plants, etc. The efforts of member countries to develop food preservation industries are noteworthy and during the West African Industrial Forum held in Dakar in 1985, 50 out of 100 projects established were related to food processing.

24. The national programmes in reducing post-harvest food losses were also supported in many cases by national research and technology development institutes. Some institutes made quite valuable achievements in manufacturing post-harvest tools including threshers, winnowers, maize-shellers and other concentrated efforts in food technologies. A list of such national institutes is given in annex II. An important component of measures taken by member States to reduce post-harvest food losses is the establishment, in some cases, of national co-ordinating units charged with the co-ordination of inter-departmental and inter-institutional activities.

2. Role of African subregional and regional organizations

25. Besides the national programmes, some African subregional and regional organizations promoted, directly or indirectly, activities aiming at preserving food and reducing post-harvest food losses. In West Africa, the Permanent Inter-State Committee for Drought Control in the Sahel (CILSS) have carried out several storage improvement activities as part of the regional food security programme in the Sahel. The Central African member States have established in Yaounde, Cameroon, a Regional Centre for Training in Plant Protection. In Eastern and Southern Africa, the newly established Association of Food Marketing Agencies (AFMESA) instructed its members to co-operate in tackling the problem of post-harvest food losses. Also, the Southern African Development Co-ordination Conference (SADCC) established the Post Production Food Industry Advisory Unit (PFIAU) as one of the operative arms of its food security programme, of which the objective is to "critically assess the post-production food systems in each member State and to initiate programmes to ensure that sufficient food is more readily available through loss and waste reduction (especially in storage) in a cost-efficient manner; to critically evaluate the food processing and loss prevention systems and to introduce innovations and improvements to existing technologies that will improve the achievement of food security in a cost-effective manner". In North Africa, the Arab Organization for Agricultural Development (AOAD) and the Centre d'étude industrielle maghrebin have undertaken several activities aiming at improving food storage conditions. Also, the Regional Marketing Project for the Near East was involved in activities aiming at reducing post-harvest food losses in some North African countries.

26. At the regional level, the Organization of African Unity (OAU) has established the Inter-African Phytosanitary Advisory Council which has promoted activities related to eradicating major crop-pests. The Council, inter alia, mobilized member countries and development agencies for an exchange of information on how to combat Trogoderma granarium. At the regional level too,

the Comite interafricain de technologies post-recolte (CITPR), which is composed of African researchers, initiated the development of a regional network for the improvement of post-harvest operations.

3. Role of the United Nations system

27. Following the resolution of the General Assembly, several United Nations agencies/organizations included in their regular work programmes activities oriented to reduce post-harvest food losses. ECA, which, inter alia, played a major role in the formulation of the Lagos Plan of Action and Africa's Priority Programme for Economic Recovery (APPER) spared no efforts in sensitizing its member States on the importance of preventing and reducing post-harvest food losses. ECA convened several expert consultations/meetings on the issue and collected, through a questionnaire addressed to all African countries, as much data as possible on post-harvest food losses and in particular ongoing programmes. In 1982, the Commission convened the initial inter-agency meeting on food-loss prevention. It also incorporated in its work programme several projects aiming at improving food marketing systems in general and preventing post-harvest food losses in particular.

28. For instance, through the joint ECA/FAO Agriculture Division, the Commission implemented the following projects and programmes in this field:

(a) Study on food loss at storage points. The global study covered the whole region and aimed at reviewing the general situations analyzing the policy implications and providing a framework for improving planned programmes;

(b) Integration of women in the development process. Pilot project on the reduction of food losses. This project was of a pilot nature and covered Togo and Sierra Leone;

(c) Study on post-harvest food losses in fruits and vegetables. As a follow-up of the project on the role of women, ECA assessed the main causes and magnitude of losses of fruits and vegetables in Togo;

(d) Prevention of post-harvest food losses in Africa. This regional project is aiming at assisting member States and subregional intergovernmental organizations in their efforts in combating the two problems of post-harvest food losses and food shortages. The project has a subregional approach in scope and gives emphasis to main staples;

(e) Survey of constraints to improved storage facilities in Central and North Africa. This study formed the basis of a report which discussed the crucial issues pertaining to a significant reduction of food losses in storage and the salient factors underlying storage improvements. The report was presented to the seventh meeting of the Technical Preparatory Committee of the Whole in 1986;

(f) Prevention of food losses through insect pest management and use of small-scale and low-cost farm equipment. The project is a pilot scheme, aiming at introducing at small farmers' level integrated pest management methods for the control of crop pests. It is being implemented in collaboration with the International Centre of Insect Physiology and Ecology (ICIPE); and

(g) Seminars and workshops. The activities of the Commission related to post-harvest food losses are associated with seminars and workshops with a view to creating fora for the exchange of experience between African specialists. In this framework, a seminar on the reduction of post-harvest food losses in West Africa was organized in Lome, Togo in February 1987. For Eastern and Southern Africa, a similar forum is planned for May 1987, in collaboration with ICIPE. For the Central and North African subregions, seminars on the issue of reduction of post-harvest food losses are planned for 1988 and 1989 respectively.

29. The Action Programme for the Prevention of Food Losses (PFL) of the Food and Agriculture Organization was established in 1977 in Rome to assist developing countries and more particularly the least developed and the most seriously affected by food shortages in their efforts to increase food availability. The FAO programme on post-harvest food losses consists of practical projects including improving farm and village storage structures, promoting small-scale grain dryers and other improved processing tools and constructing and managing pilot warehouses. Although most of the projects under the Food and Agriculture Organization Prevention of Food Losses (PFL) programme are related to loss prevention in food grain, the Organization provided assistance to several African countries in preserving roots and tubers. FAO also provided valuable solutions in the elaboration of standard loss assessment methods and published quite a sizeable number of technical documents regarding various aspects of post-harvest food losses. All FAO practical activities included training components and national and regional seminars with a view to establishing a network of institutions involved in post-harvest loss prevention. Besides its national projects in most of the countries, the following activities were organized at the regional level:

(a) African regional programme of higher education in the prevention of food losses;

(b) FAO/IITA Training Workshop on post-harvest technology; and

(c) FAO/ARCT African Regional Workshop on national programming and inter-country co-operation in the prevention of food losses.

Table 4 gives the numbers and budgets of country projects (groups in subregion) and of regional projects implemented by FAO between 1977 and 1986.

Table 4: Country and regional projects undertaken by FAO between 1977 and 1986 in sub-Saharan Africa

Country projects in Subregions 1/	Number of projects and budgets in US dollars							
	Pipeline		Operations		Completed		Total	
	No.	Budg.	No.	Budg.	No.	Budg.	No.	Budg.
Central Africa (4 countries)	1	616,575	1	409,719	3	709,352	5	1,735.656
Eastern and Southern Africa (11 countries)	12	9,201,319	13	3,405,103	8	1,275,192	33	13,881,614
Great lakes countries (2 countries)	1	400,000	1	150,000	4	1,275,433	6	1,825,433
West Africa (15 countries)	8	4,455,858	6	1,489,084	23	7,690,355	37	12,635,297
Subtotal (32 countries)	22	14,673,752	21	5,453,916	38	9,950,332	81	30.076,000
Regional Projects	4	2,339,108	2	174,660	3	331,891	9	2,825,659
Grand total	26	17,012,860	23	5,628,576	41	10.262,223	90	32,903,659

Source: Extracted from FAO Prevention of Food Losses Programme data sheets, GASGA Project Catalog, compiled on 21/11/1986.

1/ In brackets are the number of countries concerned by projects in a given subregion.

30. Other United Nations organizations including those mentioned below have been actively involved, either directly or through funding, in activities related to prevention and reduction of food losses:

(a) The World Health Organization (WHO), in collaboration with Food and Agriculture Organization (FAO), established the Codex Alimentarius Commission in order to assist developing countries in food quality control;

(b) The International Fund for Agricultural Development (IFAD) supported several countries' projects and associated training programmes;

(c) The United Nations Environment Programme (UNEP) supported the FAO/WHO Codex Alimentarius Commission and initiated activities on fungal contaminants control in food;

(d) The United Nations Industrial Development Organization (UNIDO) implemented several country and regional projects aiming at improving post-harvest technology, including food storage and processing; and

(e) The United Nations Development Programme (UNDP) funded quite a number of the Prevention of Food Losses (PFL) projects executed by FAO, UNIDO and African national and subregional institutions.

4. Role of development agencies

31. Several development agencies, non-governmental organizations and international research institutes assisted African member States in their food-saving programmes. As not all of these organizations/institutions have widely publicized their activities, only the role played by some of them are documented here and more particularly that of the members of the Group for Assistance on Systems Relating to Grain after Harvest (GASGA) which is a voluntary association of organizations/agencies directly involved in tackling post-harvest problems. GASGA is a technical association of international character established in 1972 following a recommendation of a seminar on the storing of grain, particularly in the humid tropics which took place at Ibadan, Nigeria in July 1971. Presently, the association is composed of the following eight members:

(a) The Commonwealth Scientific and Industrial Research Organization (CSIRO);

(b) The Food and Agriculture Organization (FAO) of the United Nations;

(c) Deutsche Gesellschaft Fur Technische Zusammenarbiet (GTZ);

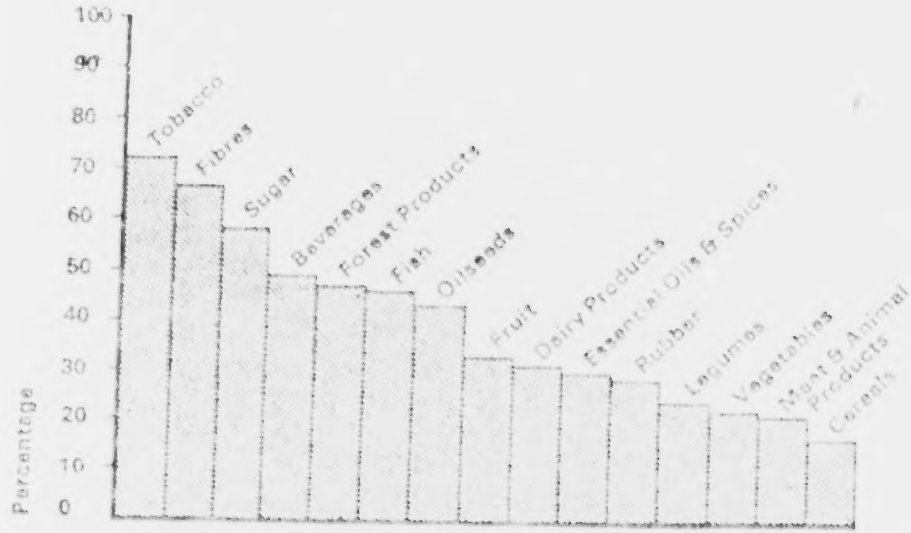
(d) The Institut de recherches agronomiques tropicales et des cultures vivrières (IRAT-GERDAT);

(e) Koninklijk Instituut voor de Tropen;

(f) The Food and Feed-Grain Institute of Kansas State University; and

(g) The Tropical Products Institute (TPI).

The proportion of the total value of each commodity group added post-harvest within LDC's—1970.



Source: Post-harvest improvements of the 1980s and 1990s, Proceedings of the tenth anniversary seminar of the CASGA, June 1981.

32. The members of GASGA have been involved in the provision of professional advice, the conduct of field projects, the training of personnel and the conduct of the research and its applications, in relation to problems of post-harvest systems in grain and other food commodities in developing countries including Africa. For example, it appears from GASGA projects data sheet that IRAT conducted 9 country projects in Africa; that GTZ is involved in 22 country projects, 2 regional projects and 5 supraregional projects and that IDRC is supporting 20 country projects in Africa. Also, the Tropical Products Institute which has the responsibility, within the British Overseas Development Administration (ODA), for assisting the least developed countries (LDCs) to overcome various aspects of post-harvest problems, has implemented in many African countries several projects related to food storage improvement, processing quality-control, post-harvest economics and food marketing.

33. Apart from the members of GASGA, some development agencies and more particularly from the OECD countries have significantly assisted member countries in the improvement of post-production systems. The United States Agency for International Development (USAID) funded two notable projects on post-harvest loss subjects. The first was a report prepared by an ad hoc advisory panel of the Board on Science and Technology for International Development, entitled "Post-Harvest food losses in developing countries" and the second resulted in a manual entitled "Post-harvest grain loss assessment methods", prepared by the League for International Food Education and the American Association of Cereal Chemists, with the assistance of several members of GASGA. In addition, USAID has provided assistance in many African countries through grain storage and marketing projects. Besides the above-mentioned contributions, the activities of some Africa-based international research institutions and some non-governmental organizations are worth mentioning. These include the International Institute of Tropical Agriculture (IITA), the West African Rice Development Agency (WARDA), the International Centre for Insect Physiology and Ecology (ICIPE). The voluntary organizations which provided valuable contribution in the improvement of post-harvest systems include the United States Peace Corps and the Volunteers in Technical Assistance (VITA).

B. Main aspects of improvements in the post-production systems

34. The importance of the results achieved will be different from one country to another depending on the prevailing situation, the traditional practices and the relative importance of the efforts made to overcome the shortcomings. Also since much attention was paid in general to food grains, the major achievements made are related to loss assessment, improvement of storage conditions and processing of grains. Relatively less improvement has been made for preserving perishables.

1. Improvement in loss assessment

35. It should be recalled that following the adoption of the resolution calling for a 50 per cent reduction of post-harvest food losses by 1985, an interdepartmental sub-committee was set up by the United Nations Secretariat to review past and current activities related to reduction of post-harvest food losses. The sub-committee concluded, inter alia, that:

(a) There is no agreed methodology of post-harvest loss assessment. Moreover, loss data are generally unrelated to the cost of loss reduction;

(b) There can be no agreed single figure for the percentage of post-harvest losses on a global scale or even on a national basis; and

(c) There is clearly a need for more accurate assessment of these losses, to establish firm justification for the development and introduction of measures designed to reduce them where the cost/benefit ratios of corrective measures are favourable.

The concern of the sub-committee was fully justified as in the past, loss estimates were not reliable and since any progress towards the goal of significantly reducing losses could only be attained if reasonable quantitative loss estimates were available. It was therefore necessary, as a matter of priority, to integrate activities aiming at reducing losses with the assessment of the nature, causes and magnitude of such losses.

36. For food-grain, the lack of standardized estimation methodology was rectified with the preparation in 1978 by Harris and Lindblad of the manual "Post-harvest grain loss assessment methods" (see annex IV). This reference manual has allowed research workers to carry out estimations in various locations in such a manner that results could be easily comparable. However, it appeared that estimated loss figures can vary from season to season for a given crop in a given location. The manual prepared by Harris and Lindblad has therefore been further elaborated and methods adopted to specific situations. Moreover, because obtaining precise assessment has been found highly expensive, the process of assessment has been adapted to requirements of projects and can range from a broad estimate to precise figures. Practically, it has been suggested that losses be assessed at the various stages of the post-harvest operations and precise estimation be made at the stage where the maximum losses occur. For perishables, although pilot attempts to establish methods of assessment have been conducted, no standardized methodology is broadly accepted at present. Improvement of loss assessment method has not only contributed to more loss estimate out of the realm of guesswork. Its continuous refinement, through pilot projects, has allowed proposals for alternative ways of reducing losses to be made in the light of cost/benefit ratios and enable progress in replacing traditional methods by improved practices to be monitored.

2. Improvement of storage conditions

37. As a result of its post-harvest loss assessment activities, FAO concluded in 1980 that more attention should be paid to storage because it is at this stage that losses are easily estimated, avoided or reduced. Also, with the increased attention paid to food security strategies in Africa, there has been a corresponding increase of resources allocated to improving both central and on-farm storage facilities. In the past, efforts to overcome storage problems in Africa were mainly aimed at killingpests, using a wide range of pesticides. In view of the fact that such methods were not suitable to farmers (particularly the small farmers) due to the cost of the imported chemicals and the danger they could cause, efforts have been oriented towards identifying solutions involving the existing farming systems. The goal was to improve storage structures so that stocks are protected against climatic effects (heat and humidity), post infestation and rodents attack. It has been unfortunate that early in the 1960s the technology package proposed to African countries

for improving storage structures was that developed overseas, proper for European products and farming systems and not in most cases, necessarily suitable to local conditions. Also in the past, priority has been given to urban central stores composed of modern warehouses or silos built of sheet metal or masonry, with corrugated iron roofs, supported by elaborate steel frames. Apart from the high costs of the construction materials which were totally imported, the lack of qualified technical and managerial manpower for the running of these structures made them inefficient. Later on, it became clear that preserving food stocks only at central storage level did not help to significantly reduce post-harvest food losses as about 75 per cent of the aggregated food production were retained on farms. Therefore, activities were geared towards improving on-farm storage. Some aimed at adapting the traditional structures and others aimed at developing new types of rural stores, taking into account important criteria such as local availability of materials, ease of construction, good thermal conditions, adequate ventilation and reliance on local labour for all construction work. The idea was to present the farmer with something appropriate to the environment, familiar to him in shape and easy to construct within his limited resources. For instance, very rapidly improved basket stores, mud brick-walled stores, mud silos, plastered ferro-cement stores have been successfully promoted in rural areas.

38. Not only have efforts been made to adapt stores to prevailing socio-economic and climatic conditions but also to improve rodent and insect control measures. Although the use of chemical pesticides was still recommended, efforts have been made to develop natural pesticides and to promote traditional pest-control methods. Furthermore, plant breeders have successfully included resistence to pests in selecting new varieties of staple seeds. Similarly to loss assessment, improvement of storage conditions concerned more food grains and less perishables. Attempts are being made to develop field grading and packing systems for fruits and vegetables and to adapt traditional barns, clamps, underground pits for storing roots and tubers. For fresh fish, experimental low-cost cooling, solar powered or not, is being promoted. The above-mentioned achievements clearly show that at least technically, substantive improvements of storage conditions have been made over the period.

3. Improvements in food processing

39. It is noteworthy that the main food grains that are easiest to grow in Africa (sorghum, millet, maize, rice) are difficult to be processed into ready-for-consumption forms. Using traditional methods, rural housewives spend from two to five hours per day on dehulling, winnowing and grinding grains by hand. Quite apart from the drudgery, the process brings about substantial losses. Therefore, improving both primary and secondary processing methods would have not only reduced losses but would also introduce the small farmer and especially his wife to a better way of life. Unfortunately, processing local food has received less attention during the past 10 years. As indicated in the following chart, the increased post-harvest value of main agricultural commodities remained low and more particularly as far as food commodities are concerned.

40. With regard to primary processing of food grains, including drying, threshing, shelling, hulling and winnowing, the sophisticated imported machinery developed for large-scale farming systems were simply beyond the means of

African farmers to acquire, operate and maintain. It is also true that research in agricultural equipment concentrated more on pre-harvest operations and less on post-production operations. However, some agricultural engineering institutes and appropriate technology development organizations made valuable work in designing and constructing simple types of machinery which are suitable and affordable to small farmers. The key problem has been that manufacturers in developed countries are no longer interested in the production of such machines considered obsolete and that the industrial section in most African countries is not able to build them. A list of some manufacturers of simple equipment for food grains primary processing is given in annex III.

41. With regard to secondary processing of food, less consideration was given to local produce. For cereal grains, small-scale milling machines for grinding millet, sorghum, maize after they are dehulled, have been developed and widely promoted in urban areas in most of the countries. Still the dehulling has to be done in the traditional way, by hand in most cases. It is only recently that dehuller machines were introduced in some countries. An example of such a machine is the PRL dehuller which prototype has been developed by an International Development Research Centre (IDRC) project in 1973 but introduced in some rural areas in the 1980s. Also more recently, since wet-milling has proved to lead to poor grinding (the resulting flour is saturated with water), mills for grinding dry cereals have been developed. Furthermore, multi-purpose mills which can process cereals and tubers are now available. Large-scale commercial mills have also been established in urban areas but mainly to process imported wheat, in most cases in sub-Saharan Africa, with the exception of Kenya, Zambia, the United Republic of Tanzania, Nigeria and Zimbabwe where such facilities have been used not only for wheat but also for maize. In these countries, multistage large-scale mills allowed the removal of the germ which is further processed to extract oil. This multistage process has the two advantages of producing a whiter flour which has a longer shelf-life and of producing cooking-oil and industrial starch and glucose in some cases. Apart from the development of milling facilities, it is unfortunate that the most popular agro-industry in Africa remains the breweries. Producing local beverages using local grains has also been found energy-consuming. Modern breweries are using imported malt and it is only recently that a little quantity of local grains is incorporated in the process. Also, making beer or other alcoholic beverages using local cereals is not a proper way of preserving food since the process simply halves the caloric value of the food used (the process simply inducing a net loss of 50 per cent). Processing local grains to nutritious food such as biscuits, breakfast meals, etc., has not been given the right consideration. It is only recently that bread making and post-production processes involving composite flours (replacing 5 to 30 per cent of wheat by millet, sorghum, maize and cassava flour) have been promoted.

42. For root crops, a breakthrough in processing has been principally made in the case of cassava. In West Africa in particular, the traditional manual methods of making gari and cassava flour have been mechanized and adapted to semi-industrial and industrial processes. In Nigeria, for example, various types of gari manufacturing lines have been developed and the most popular type was locally designed and built by FABRICO Nigeria Limited. Concerning fish processing, canning has been the major process of preserving fresh fish. The process has been more developed in North Africa and less in sub-Saharan Africa. Traditional methods of curing fish have been significantly improved. Solar dryers have been promoted and smoking has been mechanized in some countries. More recently, a Geneva-based association called "Technology for

the People" designed a new process of making flour of fish protein concentrate (FPC). With regard to fruits and vegetables, processing improvements have been limited to the development of canning facilities and solar drying. However, these methods are not widely developed in most countries.

III. CONCLUSIONS AND RECOMMENDATIONS

43. The chapter on achievements in preventing and reducing post-harvest food losses during the period from 1975 to 1985 clearly shows that the resolution adopted by the seventh special session of the United Nations General Assembly was fully endorsed by African member countries and the international community. All concerned parties have contributed to a better knowledge of the causes and nature of post-harvest food losses, to sharpening loss assessment methods and to the improvement of the situation which prevailed in the past. There is no doubt that presently most of the requisite knowledge for prevention of post-harvest food losses exists. However, the actual level of the losses remains high in many developing countries, including those in Africa. The key issue is therefore how the knowledge gathered during the past 10 years could be used to tackle the problems.

44. Measures taken by African member countries and the supportive activities undertaken by the international community towards the reduction of post-harvest food losses have had varying impacts, depending on the efficiency of national institutions established for the purpose and the socio-economic environment in each country. For instance, from various studies and surveys, it appeared that in 1985, volume loss of cereal grains procurred by the Grain Marketing Board in Zimbabwe did not exceed 1 per cent while in Chad, losses during the handling and storage were estimated to be as high as 20 per cent. Also in the past, magnitude of post-harvest losses of cassava was as high in Nigeria as in Rwanda. Although this commodity is a staple food in both countries, losses have been more significantly reduced in Nigeria than in Rwanda because improved handling and processing systems for this commodity have been widely promoted there. It has also been reported that in Mali, measures for improving storage conditions, associated with the national food strategy, contributed to the reduction of cereal losses from 12 to 7 per cent between 1980-1981 and 1983-1984. 3/ Furthermore, more resources have been generally allocated to improving storage facilities for export crops and urban central stores and less to improving village and on-farm storage facilities. Therefore, in spite of the commitment of African Governments to reduce post-harvest food losses, there has been in most cases inadequate infrastructure to implement a sound loss reduction programme in the rural areas. In addition the support that member countries received from the international community did not always produce the expected result due to the fact that in many countries related activities were generally dispersed in a number of official and non-official departments/agencies. Moreover, the right attention was not given to socio-economic aspects when conceiving related programmes. There is no doubt that the farmers' readiness to accept advice, their ability to pay for improvements, the benefit they may expect to get by adopting proposed improvements are the major factors in the successful implementation of any programme. Although there is no panacea for the practical reduction of post-harvest food losses and any programme should be considered in relation to local circumstances, it is proposed that future strategy focus on the following policy measures to be implemented respectively at the national, subregional and international levels.

3/ Afrique Agriculture No. 110. October 1984, page 45.

A. At the national level

45. In the spirit of Africa's Priority Programme for Economic Recovery (APPER) in which African member States reiterated their continued full commitment to the basic principles of the Lagos Plan of Action, Governments are primarily responsible for the economic development of their countries, including improving availability of food to their people by promoting agricultural development and reducing post-harvest food losses and waste. Not only must Government awareness of the importance of post-harvest food losses should be maintained, but also related activities must be integrated in member countries' agricultural development programmes and the following requisite elements should be made available to the extent needed:

(a) The establishment, where it does not yet exist, of a national post-harvest co-ordinating unit charged with the responsibility of food-saving programmes. For making the unit operational and efficient, adequate human and financial resources should be allocated to it;

(b) The availability of qualified technical staff and more particularly within the extension services. With regard to training of farmers, apart from the fact that women workers should be included in the extension programme, the training itself must be addressed more to rural housewives who are performing most of the post-harvest operations;

(c) The development of suitable marketing infrastructure and the provision of the right incentives to farmers. Infrastructural development would include the improvement of transportation systems in rural areas, the establishment of small packing stations and more particularly for perishables. Incentives to farmers would include attractive and timely remunerative price for good quality products and establishing a suitable financing mechanism to assist farmers and especially the resource-poor ones to adopt improved or appropriate technologies in harvesting, drying, threshing, winnowing and storing; and

(d) The promotion of research and development which embraces all aspects of the post-harvest systems and involving national universities and research institutions. Research and development activities would include the development of standardized loss assessment methods and ensure orderly and sound processing methods without neglecting some of the existing traditional methods.

B. At the subregional level

46. Due to the lack of adequate technical skills, equipment and financial resources, most African countries were not able individually to make a breakthrough in technological development for improving post-harvest operations. Subregional co-operation is however necessary to promote and strengthen research and development, design and engineering and the exchange of experience. Effective co-operative activities would require:

(a) The establishment of subregional institutions responsible for food strategies and charged with specific activities that are of common interest to concerned countries and whose implementation is beyond the means of an individual country. The African Regional Centre for Engineering Design and Manufacturing (ARCEDEM) could for instance give more importance to the development of post-harvest technologies in its programmes. Other areas of

importance should include technological development for food preservation and processing, testing pesticides and pest management and control methods; and

(b) The establishment of subregional post-production committees which will prepare and up-date inventories of post-production technologies of particular interest to the concerned countries; organize fora for exchange of information in order to ensure that innovations or improvements achieved in some countries could be beneficial to others facing similar problems.

C. At the international level

47. The efforts of the many international organizations, national development agencies and voluntary organizations, in support of activities related to post-harvest food losses in African countries, must be intensified. The valuable activities in loss assessment or aimed at a better knowledge of various tropical post-harvest systems have been useful but rather expensive. Future actions in assisting member States should be more action-oriented and should include the following:

(a) Continued co-ordination of activities not only related to cereal grains but also to perishables and more particularly to root and tuber crops which are equally important in the diet of African populations;

(b) Giving more emphasis to training since the capability of countries to implement practical programmes will depend upon the availability of qualified technical staff. Such training would include technology application, maintenance, adaptation and development and should be associated with seminars and workshops in order to facilitate exchange of information and promotion of international co-operation;

(c) Strengthening the technological capability of member countries in food processing methods and particularly in those adapted to processing local food commodities;

(d) While the scope of bilateral co-operation between developed and developing countries exists, linkages among developing countries should also be strengthened in this field; and

(e) The international community could provide member States with practical aid which could integrate actions aiming at reducing post-harvest food losses in the general technical and economic assistance.

48. Food losses would be significantly reduced if the whole post-production system including harvesting, processing, storing, handling, transportation and distribution is improved and should be viewed as part of overall development plans and programmes and not as isolated phenomenon. Unless efforts are intensified at all levels, including provision of adequate incentive packages in this field, the achievement of self-reliance in food will still remain an elusive goal on the continent.

Annex I

LIST OF COMMON INSECT PESTS IN RURAL AND URBAN CENTRAL STORES IN AFRICA

Insect pest		Susceptible commodity
Grain weevil	Sitophilus granarium	Wheat
	Sitophilus orizea	Rice
	Sitophilus zea mals	Maize
Flour beetle	Tribolium confusum	All cereals
	Tribolium castaneum	All cereals
Lesser grain borer	Rhyzopertha dominica	All grains in warm and humid countries
Khapra beetle,	Trogoderma granarium	All grains in dry and hot countries
Moth	Lepidoptera as Plodia, Ephestia, Sitotraga, Nemapogon	All cereals in warm and dump storage conditions
Flat grain weevil	Cryptolestes	Rice
Mites	Acarus siro and others	All grains in dump storage conditions
Dried beanbeetles	Acanthoscelides objectus Zabrotes subfascinatus	All pulses
Groundnut borer	Caryedon seratus	Groundnuts
Greater grainborer	Prostephanus truncatus	Maize on cobs

The order in which the pests are written down reflects more or less their importance in Africa.

Annex II

LIST OF SOME AFRICAN NATIONAL INSTITUTIONS INVOLVED IN THE IMPROVEMENT/DEVELOPMENT OF FOODGRAIN STORAGE AND PROCESSING METHODS

Institut de recherche agronomique tropicale et des cultures vivrières Niaouli	Benin
Rural Industries Innovation Centre	Botswana
Centre ivoirien de recherches technologiques Abidjan	Côte d'Ivoire
Technology Consultancy Centre University of Science and Technology Kumasi	Ghana
Garu agricultural station	Ghana
Department of Mechanical Engineering University of Nairobi	Kenya
Village Technology Unit Nairobi (Keren)	Kenya
African Rural Storage Centre International Institute of Tropical Agriculture Ibadan	Nigeria
Nigeria Stored Products Research Institute Federal Ministry of Trade Ibadan	Nigeria
Institut de technologie alimentaire Dakar	Senegal
Food Research Centre Khartoum (Shambat)	Sudan
Tanzanian Agricultural Machinery Testing Unit Arusha	Tanzania
Association pour le développement de l'animation Rurale Tunis	Tunisia
CEDECO Kimpese	Zaire
Mont Makulu Research Station Chilanga	Zambia

Type of equipment	Manufacture
	Projects Development Institute (PRODA), National Science & Technology Development Agency, 3 Independence Layout P.O.Box 609, Enugu Nigeria
	Société Ivoirienne de Technologie Tropicale (12T) 04 B.P. 1137 Abidjan 04 République de Côte d'Ivoire (Telex 3347) Telephone 33 23 60; 321 79)

Annex III

LIST OF SOME AFRICAN BASED MANUFACTURERS CONSTRUCTING TOOLS AND MACHINES PROPER TO POST-HARVEST OPERATIONS FOR TROPICAL PRODUCTS

Type of equipment	Manufacture
Treeshakers	SISMAP, Senegal RIIC, Botswana
Winnowers	SISMAR, Senegal Village Technology Unit, Kenya
Hulling machines	SISMAR, Senegal ABI, Côte d'Ivoire
Decorticators of groundnuts	SISMAR, Senegal ABI, Côte d'Ivoire
Maize shellers	SISMAR, Senegal Village Technology Unit, Kenya
Equipment for processing cereals	Nanchula Mechanical and Machine Tools Co. Ltd. P.O.Box 30, Kagbula, Morogoro United Republic of Tanzania
	Mwanza Engineering Works P.O.Box 507, Mwanza United Republic of Tanzania
	Mike Motors, Auto Engineers P.O.Box 207, Moshi United Republic of Tanzania
	D & P Investors P.O.Box 820, Mwanza United Republic of Tanzania
	Hanil Engineers Manufacturers of Maize Mills, Factory Area P.O.Box 1274, Arusha United Republic of Tanzania
Equipment for processing cassava	Agricultural Engineers Ltd. Ring Road, West Industrial area P.O.Box 3707, Accra Ghana
	Fabrico Nigeria Limited Lagos, Nigeria

Annex IV

SELECTED BIBLIOGRAPHY

Post-harvest improvements for the 1980s and 1990s. Proceedings of the tenth anniversary Seminar of the Group for Assistance on systems relating to grain after harvest (June 1981).

Post-harvest food losses in developing countries, National Academy of Sciences, Washington (1978).

Post-harvest grain loss assessment methods, developed and compiled by Kenton L. Harris and Carl I. Lindblad, American Association of Cereal Chemists.

Small farm grain storage, peace corps/VITA information collection and exchange, manual M-2.

Le contrôle de l'infestation des denrées stockés par Trogoderma Granarium et Prostephanus Truncatus, Compte rendu d'un séminaire international renu à Lome/Togo du 10 au 15 decembre 1985. Deutsche Gesellschaft fur Technische Zusammenarbeit (GTZ).

The lost harvest, Food and Agricultutre Organization (FAO).

Post-harvest losses in quality of food grains, FAO Food and nutrition paper No. 29.

Processing and storage of foodgrains by rural families, FAO Agricultural Services bulletin No. 53.

Prevention of post-harvest food losses: A training manual, FAO.

The Prevention of Losses in Cured Fish, FAO Fisheries Technical Paper No. 219.

Report of the Workshop on production and marketing constraints on roots, tubers and plantains in Africa, Kinshasa, Zaire, September-October 1985, vol. II, FAO.

Rapport d'une mission de consultation du 25 mai au 30 juillet 1972 sur les pertes alimentaires par G.G.M. Schulten, FAO.

Report on interagency meeting on food loss prevention and encroachment on arable land, Rome, 6-7 September 1983, FAO.

Survey of constraints to improved storage facilities in Central and North Africa, Economic Commission for Africa. Document E/ECA/CM.12/1.

Pre-feasibility study on integration of women in development: Pilot project on reduction of food losses (Case study: Togo), 1984, ECA.

The role of women in the marketing of fruits and vegetables in Togo. Pilot project on reduction of food losses, ECA, 1985.

Review of programmes and strategies of intergovernmental institutions to reduce food waste and losses in Africa, ECA, 1985.

Effectiveness of marketing institutions and services in reducing food losses in Burundi, Rwanda and Zaire (Kivu region). Regional project on prevention of post-harvest food losses, ECA 1986.

Technical Compendium on Composite Flours, technologies available for application, ECA, 1985.

Appropriate industrial technology for food storage and processing. Monographs on appropriate industrial technology No. 7, United Nations Industrial Development Organization (UNIDO), 1979.